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common soil and fertilizer questions·answers

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COMMON SOIL AND FERTILIZER

QUESTIONS AND ANSWERS

Prepared by members of the Soils Branch, Alberta Agriculture

Edmonton, Alberta

This document contains brief answers to commonly asked questions concerning soils and fertilizers. Answers are not intended to be all-inclusive. Instead, answers are intended to be brief and factual. They are the type of response one would give in answering a question on a telephone where information is needed to make an immediate decision.

It is difficult to condense years of research data and often conflicting points of view into a one or two paragraph statement. However, we hope this approach may prove valuable as a starting point for decision making and in providing advice. When more detailed answers are required, it will be necessary to consult other sources of information.

Additional resource information is referred to at the end of some answers and in the appendix of this document. Other information is available from your local district agricultural office, the regional plant industry specialist or the soils branch.

The writers wish to acknowledge that this document was based on a similar publication prepared by Dr. Paul Kresge, Extension Soil Specialist with the Montana Cooperative Extension Service, Montana State University, Bozeman. We are grateful for his ideas and initial work which resulted in this document.

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SECTION I. GENERAL FERTILITY

I.01

Q. I have a limited amount of money. Where is the best place to cut back on fertilizer?

A. There is no best place to cut back. Fertilizer is not a luxury expense item but an input capable of producing high returns.

However, if your banker is still not convinced, then cut back on land where production is limited by factors other than fertility e.g., saline, depressional, or poor physical condition in the field. Such land does not return as much per dollar invested in fertilizer. Be sure to apply the full recommended amount of nutrient on the most productive land. It is important to have a soil test to assure accurate recommendations, because land that has been fertilized or manured for several years will show a nutrient build up. Thus the fertilizer requirement may be less than has been routinely used.

- Also see - *How to Get the Most From Your Soil Test Results* Agdex 533.

I.02

Q. Is it true that fluid fertilizers are more available to the plant than dry materials?

A. No. Fluid (clear liquid and suspension) and dry fertilizers go through the same reactions in the soil and have the same availability. Dry fertilizers quickly dissolve in the soil solution and behave the same as the fluids. If there isn't sufficient soil water to dissolve dry fertilizer, there isn't sufficient water for plant growth with either dry or fluid fertilizers.

The decision of whether to use dry or fluid fertilizer should be based on the cost of the material, storage and handling cost, and the ease of application.

I.03

Q. Is dual application, also called double shooting, an acceptable application method?

A. Yes. Dual application refers to placement of both nitrogen and phosphorus in the same band. One approach is to band anhydrous ammonia and phosphate fertilizer together. Another is to band granular ammonium phosphate and urea. Both methods work well. When nitrogen and phosphorus are placed together in a band they are frequently more effective than when broadcast and mixed into the soil, especially in dry years. Nitrogen in the band ususally increases the availability of phosphorus. Dual banding of N and P is as effective as banding N and placing P in the seed row except on very low testing P soils where some seed placed P may be beneficial.

- Also see - *Fertilizer Placement* Agdex 542-5

I.04

Q. Why have organic matter levels been decreasing in many of our soils?

A. Cultivation, especially summerfallowing, contributes greatly to the decline in organic matter. Summerfallowing causes an increase in soil temperature and soil water, both of which hasten the decomposition of organic matter. We've been using the nitrogen released from this process for several decades. Is it because of decomposition that soil nitrate levels are usually much higher following a fallow year than after recropping. It has been shown that switching from alternate crop-fallow to continuous cropping can cause soil organic matter to build up.

I.05
Q. Will burning of stubble or other crop residue be harmful to the soil?

A. Yes. Much of the nitrogen and sulfur contained in the residue is volatilized and lost to the atmosphere. A dollar value can certainly be placed on the nitrogen lost. The long term effect of burning is to reduce soil organic matter. Although this aspect is difficult to state in dollars, the results are increased tillage energy requirements, more erosion, lower water and nutrient storage and generally deteriorated soil physical properties.

I.06
Q. Is leaching of nutrients a problem?

A. The answer depends upon the nutrient and the situation. Mobility of phosphorus is very low in soil so it is not leached readily. Potassium (K+) and ammonium-nitrogen are positively charged and tend to move slowly owing to their attraction to the negatively charged clay particles. Nitrate-nitrogen is negatively charged and leaches readily. Ammonium is converted to nitrate under moist warm conditions so nitrate leaching is our greatest concern. Sulphate-sulfur is also negatively charged and subject to leaching.

Because there is not sufficient rainfall in southern Alberta, and the rainfall is distributed uniformly over the growing season in central and northern Alberta, leaching of crop available nitrogen and sulfur below the root zone is normally not a problem in medium or fine textured soils. However, on coarse textured soils nitrogen and sulfur may move below the root zone especially when applied in excessive amounts. On irrigated land, leaching may be serious, depending on the soil texture and amount of water used. Nitrogen leaching can be minimized by using proper fertilizers, application rates and times, and correct irrigation scheduling.

I.07
Q. How can I minimize nitrogen leaching on irrigated crops?

A. If you find that leaching is a problem, there are several things you should do. Use ammonium forms of nitrogen which are subject to leaching only after conversion to nitrate, apply nitrogen as close to seeding date as possible, and schedule irrigation to maximize efficiency - lighter and more frequent irrigations are best. In severe cases it may be necessary to split the application into two or three increments. Split application will work best on long-season crops such as corn.

I.08
Q. When is the best time to fertilize non-irrigated small grains: fall or spring?

A. The several advantages of fall application of fertilizers (such as better distribution of labor for the farmer and usually lower prices of fertilizers in fall) make fall application a viable alternative to spring application. Time of application is primarily a concern with nitrogen fertilizer. Time of application appears to make little difference with phosphorus and potassium when these nutrients are not placed with the seed. Spring application of nitrogen has lower risk of leaching, denitrification, and losses in runoff. One also knows more about soil water conditions in the spring, allowing more accurate prediction of crop needs. The major advantage of fall application is spreading of work load. Even though some precautions are necessary, fall application is perfectly acceptable. In both fall and spring, volatilization of surface-applied nitrogen will be reduced if the soil surface temperature is below 5° to 10°C.

In northern and central Alberta urea, when broadcast and mixed into soil in the fall, produces substantially lower grain yield of barley than similarly applied urea in the spring. When nitrogen fertilizer is applied in the fall nitrate sources are generally less effective than ammonium sources. The reduced effectiveness of fall-applied N is due to over winter mineral N losses mostly by denitrification (biological conversion of nitrate into nitrogen gas under anaerobic conditions) and probably by leaching of nitrate N in light textured soils. Spring application, on the other hand, has lower risk of leaching and denitrification losses.

Ammonium-based fertilizers when incorporated into the soil are converted to nitrate and therefore are susceptible to losses from soil. The rate of formation of nitrate, from urea applied in the fall, is slowed somewhat by drilling the fertilizer in rows in the soil. This effect is further slowed when fertilizers are drilled in the soil in late fall when soil temperature of surface soil drops below 10°. Therefore, for maximum yield response from fall applications, N fertilizers should be applied in late fall rather than in early fall, and should be drilled in widely spaced rows (say 30 to 45 cm apart).

- Also see *Nitrogen Fertilizer Application in Crop Production* Agdex 542-4
- *Phosphorus Fertilizer Application in Crop Production* Agdex 542-3

I.09

Q. How should I fertilize a nurse crop when establishing a legume or grass forage crop?

A. Alberta Agriculture normally suggests that nurse crops such as small grains not be used when establishing forages. The vigor and productivity of the forage stand is depressed by the nurse crop and the effect lasts for several years. Because we don't recommend nurse crops, we don't encourage use of fertilizer for them.

If the reason for using a nurse crop is soil erosion control, the best solution may be establishing a permanent grass cover, using a grass-legume mix, or interseeding. If the reason for the nurse crop is economic, i.e., getting a crop off during the first year of establishment, then the tradeoff in terms of lower vigor and productivity of the forage crop must be understood.

If a nurse crop is desired then use adequate phosphate, potash and sulfur fertilizer but apply nitrogen at about 20-25 lb/ac less than you would normally use on the nurse crop.

I.10

Q. Can I apply herbicides with my fertilizer?

A. In some instances herbicides can be added to fertilizer materials, either by impregnating dry materials or by incorporating them into fluids. This must be done with caution because some combinations are incompatible and can be ineffective or unmanageable. Rely on your fertilizer dealer to do the impregnating because it must be done with precision and shortly before application. Dealers should also be able to check on compatibility for you.

Avoid impregnating dry ammonium nitrate. It is not advisable to blend granular herbicides with dry fertilizer owing to the big differences in particle size and the difficulty in achieving uniform application.

I.11

Q. Are fertilizers toxic to plants and animals?

A. Any fertilizer material, whether synthetic or organic, has the potential to be damaging if misused. Improper application methods and excessive rates will lead to problems with any nutrient source.

Regardless of source, use the necessary nutrients in the correct amounts, apply and manage them properly.

Some fertilizers can be harmful to animals if ingested. Therefore animal access to exposed fertilizer should be avoided.

I.12

Q. Are organic nutrient sources more available to the plant than synthetic fertilizers?

A. No. Plants only take up their nutrients in certain forms. For example, nitrogen is taken up predominantly as nitrate (NO_3); and to a lesser degree, as ammonium (NH_4). The initial product of organic nitrogen decomposition is ammonium. This ammonium, like synthetic fertilizer ammonium, is converted to nitrate and taken up by the plant. Organic nitrogen sources are more slowly available because of the length of time required for decomposition.

I.13

Q. Are there any problems with using manure as a fertilizer?

A. Manure, like other fertilizers, must be applied in appropriate quantities. The proper application rate depends upon the type and quality of manure, the soil, and the crops to be grown. Many manures have a high salt content which can build up in the soil. Analysis of the manure and soil testing can help prevent problems. Excessive manure rates can also lead to a buildup of nitrate-nitrogen in the soil. The nitrate may not hurt crop production but it is a potential source of groundwater pollution.

Costs of handling and spreading manure are often high when compared to commerical fertilizer on a "pounds of nutrient" basis. However, the benefits to soil physical condition are substantial. Manure should be utilized effectively wherever possible.

I.14

Q. Is it safe and satisfactory to blend all granular fertilizers?

A. No. There are at least two reasons why some granular fertilizers should not be blended:

(I) **Absorption of water** - Do not mix ammonium nitrate (34-0-0) with urea (46-0-0). While both products store well alone, when mixed they strongly absorb atmospheric water. In just a few hours the solid blend will turn to a slurry. Even one per cent of either product mixed with the other will cause a problem. Note that some blends of nitrogen and phosphorus fertilizer contain either urea or ammonium nitrate.

(2) **Explosion hazard** - Do not mix ammonium nitrate with elemental sulfur (S) or petroleum products. Ammonium nitrate is a strong oxidant and when mixed with elemental sulfur an explosion can be initiated by open flames or a spark. Note that ammonium nitrate wetted with petroleum products such as diesel fuel, fuel oil or gasoline can be explosive and has been used as a substitute for dynamite. Use of ammonium-nitrate for this purpose is not recommended!

I.15

Q. Are nutrient forms reported in soil test results the same as those reported in fertilizer products?

A. Yes and No. Most soil testing laboratories operating in Alberta report nutrients in the soil on the elemental basis, for example, nitrogen (N), phosphorus (P), potassium (K), sulfur (S). All nutrients in fertilizer products are reported on the elemental basis except phosphorus and potassium which are reported as the oxides phosphate (P_2O_5) and potash (K_2O). Thus, the fertilizer 10-30-10-(5) contains 10% N, 30% P_2O_5, 10% K_2O, 5% S (conversion factors: P x 2.3 = P_2O_5, K x 1.2 = K_2O).

All soil test **recommendations** for fertilizer nutrients are reported on the fertilizer nutrient basis, that is, nutrient requirements are given as pounds per acre of N, P_2O_5, K_2O, and S.

1.16

Q. Do all soil testing laboratories use the same units for reporting nutrition levels in soils?

A. No. Generally two types of units are used for reporting amounts of nutrients in soils by soil tests. They are parts per million (ppm) and pounds per acre (lb/ac). This difference in units of reporting often causes confusion when comparing soil test results from two laboratories. They can, however, be compared when the soil test results are converted to a common unit. This may be done as follows:

ppm = parts nutrient/one million parts soil
lb/ac = pounds nutrient/acre slice
a 6-inch acre slice approximately = 2 million pounds
therefore:

6-inch sample depth	12-inch sample depth
ppm = lb/ac x 0.5	ppm = lb/ac x 0.25
lb/ac = ppm x 2	lb/ac = ppm x 4

1.17

Q. How important is soil sampling to obtaining reliable fertilizer recommendations?

A. Soil sampling is one of the most important steps in a soil testing program. However, it is not a complicated procedure if one has the proper tools and instructions. First it must be recognized that soils are highly variable and to account for this variability at least 20 subsamples must be taken from different parts in a uniform field or growing area. A core soil sampling tool will ensure that the same amount and depth of soil is taken at each subsampling site. All the subsamples are placed in a clean pail and when the area has been thoroughly sampled, soil in the pail must be completely mixed. This involves careful pulverizing of all lumps and thorough mixing of all the soil in the pail to produce a uniform composite sample. Approximately 500 g of the mixture is taken from the pail to be air dried and submitted for testing.

This same procedure is used for taking samples from large and small fields or from problem growth areas. If one neglects to follow these simple procedures, an inadequate sample will be obtained which will lead to misleading and costly recommendations.

- Also see - *Soil Sampling Guide* - available from district agriculturist office.

1.18

Q. Do fertilizers acidify soil? If so, to what extent and how can the problem be corrected.

A. Yes. Some fertilizer applications may acidify the soil. One of the most acidifying fertilizers is ammonium sulphate which would require 50 kg of ground limestone to neutralize the acidity caused by a 45 kg application of this fertilizer. By comparison, a 45 kg application of urea, ammonium nitrate, or anhydrous ammonia would require 38, 27 and 67 kg of ground limestone respectively to neutralize the acidity they would cause.

Nitrogen is an essential and important plant nutrient which ususally must be applied to maintain crop yields. Soils are able to buffer the acidity caused by the application of nitrogen fertilizer. Many Alberta soils contain free lime which neutralizes the acid produced. Soils which are neutral or already acidic will eventually require limestone to neutralize the acidity in the soil. The need for limestone can be easily monitored by soil testing and checking the soil reaction (pH).

- Also see - *Liming Acid Soils* Agdex 534-1
  Crop Yields and Economics of Liming Acid Soils Agdex 534-2

1.19

Q. What is the best time of year for taking soil samples for fertilizer recommendations?

A. Nitrogen is the most variable constituent in a soil that is measured by a soil test. The best test for nitrogen can be made immediately before seeding. Because of time constraints for sampling and testing, it is impossible to handle many samples immediately before seeding. Fortunately, changes in soil nitrogen are relatively slow when the soil is cold or frozen; therefore, soil samples taken in the late fall (after October 1) give a reliable measure of nitrogen supply for spring seeded crops. Other soil nutrient test levels are less variable with time and therefore the time of soil sampling is less critical. Soil samples may be taken at any time of year when attempting to diagnose a crop growth problem.

SECTION 2. NITROGEN MANAGEMENT

2.01

Q. How late in the spring can I delay nitrogen application to small grains?

A. The best rule is to apply nitrogen in the spring as early as possible. If for some reason preplant application cannot be made nitrogen can be applied effectively up to the 5 leaf stage for small grains. Adequate rainfall or irrigation is necessary to move late applications of nitrogen into the root zone.

2.02

Q. Why is it so important to make spring application of nitrogen early?

A. Cereal grains take up most of their nitrogen early in the growth cycle: that is, during the vegetative stages. This helps establish the number of tillers, and therefore heads, per acre. Nitrogen must be available when it is needed most and it is not possible to make it up later. Early application is not as critical for long-season (warm season) crops such as corn or sugar beets.

2.03

Q. Will late application of nitrogen increase grain protein?

A. Sometimes. Several researchers have found protein increases in small grains attributable to nitrogen applications after flowering. However, the res ults have not been consistent enough to date to justify the investment. One problem may be the necessity for irrigation or precipitation to move the nitrogen into the root zone. The value of the added protein must be weighed against the added cost and inconvenience of N application. In any case, there is no substitute for adequate nitrogen fertilizer applied early in the crop growth cycle. Applications to improve protein should be viewed as over and above normal rates, not as a catch-up.

2.04

Q. Should I apply nitrogen through my irrigation system?

A. Fertigation may be a good practice on coarse textured soils where leaching is a problem. Otherwise the effectiveness is limited. By the time irrigation is required, the crop is too far along. Research has shown that all of the nitrogen requirement should be applied at seeding for spring grains, and in the fall or early spring for fall grain. Delaying application reduced yield considerably.

Fertigating with a small portion of the crop's nitrogen needs, or adding more nitrogen in good years, may be economical in some operations. In general though, the practice doesn't seem to have much applicability for small grains in Alberta. Fertigation only appears useful on long season crops such as corn on sandy soils.

2.05

Q. Will foliar feeding improve small grain yields?

A. Foliar feeding refers to spraying nutrient solution on the foliage. The nutrients are then absorbed into the plant through the leaves. For the primary nutrients (nitrogen, phosphorus, and potassium) the quantities that can be absorbed are too small and the application is usually too late to be of much use. Foliar feeding may be very effective for quickly correcting confirmed micronutrient deficiencies. Fortunately, this has not been much of a problem with small grains in Alberta.

2.06

Q. Won't fertigation and foliar feeding burn the vegetation? How much will this hurt yield?

A. Foliar application of large amounts of nutrients or concentrated solutions may damage leaf tissue, causing "burning". The cause is essentially a salt effect. The effect of the damage depends upon the extent of the burning and the growth stage of the plants. Plants will recover quickly from slight leaf damage early in the growth cycle. However, damage to the flag leaf may reduce grain yield and quality. Proper fertigation will not cause burning if the total N applied does not exceed 20 lb/acre with 2.5 cm of water.

2.07

Q. How much nitrogen can I place with the seed for cereal grains?

A. High concentrations of nitrogen and potassium with the seed reduce germination and emergence.

Low soil moisture conditions aggravate the problem, so the most caution is necessary under non-irrigated conditions. To reduce the risk of stand damage and consequent yield reduction, the following guidelines have been developed for non-irrigated fields:

Maximum Rate Of Nitrogen That Can Be Safely Drilled With The Seed.

Crops	**Soil Texture**	**Seedbed Moisture**	**LB/AC ACRE OF NITROGEN (N)* Source of Nitrogen** **Urea**	**Ammonium Nitrate**
Wheat,	Medium, Fine	Good	30	45
		Poor	20	30
Oats and Barley	Light (Sandy Loam)	Good	20	30
		Poor	15	20
Small seeded crops (rapeseed, mustard, flax & cereals underseeded with legume that is placed in the drill row)	All soil textures	All moisture conditions	10	10

* If potassium is placed with the seed, the above rates included the potassium.

2.08

Q. Do I need to add extra nitrogen if I incorporate crop residue such as straw?

A. If residue is incorporated near seeding time, it may be necessary to apply some extra nitrogen. This compensates for short term tie-up of nitrogen by microbes when decomposing residue. Straw and stubble have high carbon to nitrogen ratios and microbes will use soil nitrogen at the expense of the crop to decompose residue. The nitrogen is released again after decomposition has progressed but this may be too late for optimum yields of the current crop.

Alberta Agriculture suggests adding l5-20 kg of extra nitrogen per tonne of residue incorporated, if such quantities of residue are not normally added in the cropping program.

2.09

Q. Is there an advantage to providing starter or "pop-up" fertilizer at seeding time?

A. Traditionally phosphate fertilizer has been applied with the seed at the time of seeding. With the advent of deep banding (dual banding of nitrogen and phosphorus) the question of the need for a starter phosphorus fertilizer with the seed arises. Generally deep banding of nitrogen and phosphorus will be adequate to meet plant requirements. However, on very low phosphorus soils or under cold, wet soil conditions some seed-placed phosphorus may be beneficial.

2.10

Q. Is any special consideration required when taking and handling soil samples for nitrate-nitrogen analysis?

A. Yes. The nitrate-nitrogen test is part of the regular analyses provided in soil tests in Alberta. However, in addition to the normal procedure of taking a representative sample composed of 15-20 individual cores, nitrate samples must be air dried before transport to the laboratory. If the samples will be mailed, drying is the most practical approach.

When a moist sample warms up to room temperature, and is well aerated, decomposition of organic matter is speeded up, releasing nitrate. The additional nitrate is included in the test value, resulting in a fertilizer recommendation for nitrogen that is too low. Drying decreases the microbial activity and helps ensure an accurate test. This same process occurs in the soil but at a slower rate. Under frozen conditions it is very slow. Therefore fall sampling provides a reliable estimate of spring soil nitrogen levels. We recommend fall sampling after October 1 and preferrably as close to freezeup as possible.

For improved nitrogen evaluation, particularly on fallow, legume plowdown or manured fields, separate depth samples should be taken from 0-15, 15-30, and 30-60 cm depths. Nitrogen in soils with high levels of available nitrogen will leach below the surface (0-15 cm) and will be identified by depth sampling.

2.11

Q. Under what circumstances is it beneficial for a farmer and others to take depth soil samples? (0-15 cm, 15-30 cm, 30-60 cm)

A. Growing crops will extend roots to depths of 60-180 cm or more depending on the type of crop and soil. Although the surface soil is usually the most fertile layer, chemical and physical conditions in the subsoil can significantly affect crop rooting and growth.

Measurement of soluble nutrients such as nitrogen and sulfur is improved with depth sampling. Also depth samples provide valuable information, concerning salt accumulation, pH changes and texture differences within the root zone.

2.12

Q. Is there an advantage to applying nitrogen when establishing alfalfa?

A. No. Moderate to high nitrogen levels inhibit nodulation by nitrogen-fixing bacteria and increase weed competition. Both effects will reduce the productivity of an alfalfa stand.

Small amounts of nitrogen, perhaps less than 20 lb/ac probably won't adversely affect stand establishment. Such applications may be necessary if monoammonium phosphate (e.g. 11-51-0) is used as a source of phosphorus.

Basically the bacteria will not effectively fix nitrogen within the plant if the available soil nitrogen level is high.

2.13

Q. Don't some alfalfa stands respond to nitrogen fertilizer?

A. Sometimes. After about 5 or 6 years alfalfa stands are too old to respond much to management. They no longer fix enough nitrogen for their own needs and may respond to applied nitrogen. It is more likely that an increasing proportion of grass in these stands is giving the yield response to nitrogen. The best management practice is to plow out the stand and establish a new one.

Alfalfa is a heavy user of soil phosphorus, potassium and sulphate and ensuring adequate amounts of these nutrients are available will improve yield and longevity of the stand.

2.14

Q. Are there any problems with using urea?

A. Urea is a very good source of nitrogen however some precautions must be observed for most effective use. The risk of seedling damage is greater with urea than other granular sources of nitrogen (see rate table in answer to question 2.07). Although the plants sometimes compensate for stand damage, there is still a good possibility of yield loss at rates above those indicated.

Nitrogen will also vaporise (volatilize) from surface applied urea. Losses are greatest with high temperatures, high soil pH, low organic matter, and intermediate humidity. The best practice is to incorporate urea into the soil by banding or tillage if at all possible. Otherwise, urea should be applied when the soil surface temperature is below 10°C or air temperature is below 5°C.

Also never mix urea with a nitrate containing fertilizer since they are not compatible and will cause a slush that cannot be spread.

2.15

Q. Are the predicted yield increase curves and data obtained from research done in my area? If so, how general are the data?

A. The predicted yield increase tables are developed from research plots placed in many widely separated areas, throughout Alberta. Predicted yield increases from nitrogen will account for general soil and climatic variables within a soil zone. Specific adjustments are not included for specific soil management, texture or annual climatic variables. The effects of these variables should be discussed with your local district agriculturist.

SECTION 3. ANHYDROUS AMMONIA

3.01

Q. How does anhydrous ammonia compare to dry and liquid materials as a nitrogen source?

A. All commonly used nitrogen sources are equally effective, if they are properly applied. If we get them into the soil correctly, "the plant can't tell the difference". The major differences then are in the costs associated with each material and the efficiency of handling, application and placement.

The cost of anhydrous ammonia is typically lower per pound of nitrogen than other materials. It is the starting material used for manufacture of most other dry and liquid nitrogen fertilizers. It follows that the other materials have higher manufacturing costs. The higher analysis (82% N) also serves to reduce transportation costs. However, some special equipment is required to shank the ammonia into the soil. This equipment includes a pressure tank, pressure regulator, manifold, and distribution tubes. You will need to calculate how much nitrogen must be applied at a given price differential to pay for the added equipment.

Fertilizer materials must be evaluated in terms of how well they fit into your operation. Savings may be realized by combining ammonia application with a normal tillage operation using the "cold flow" method of applying liquid ammonia. It may also prove to be a more convenient material to handle. On the other hand, there are some restrictions on how and when it can be used which may limit use in your operation. For example it can't be used on established forage, nor will it work easily into no-till small grain situations.

- Also see - *Economics of Alternative Methods of Anhydrous Application* Agdex 825-14

3.02

Q. Is anhydrous ammonia dangerous to use?

A. Yes! Two features of anhydrous ammonia require that it be handled carefully. They are:

1. Anhydrous ammonia is stored and handled as a pressurized liquid. Normal precautions used with pressure equipment are necessary. Escaping ammonia gas freezes water or whatever it contacts.

2. Anhydrous ammonia has an extreme affinity for water. It can instantaneously pull water out of human tissue, particularly damaging the eyes, nose and throat. First aid consists of applying clean water - lots of it - IMMEDIATELY, FOR 15 MINUTES.

ANHYDROUS AMMONIA USE NEED NOT BE DANGEROUS. MAINTAIN THE EQUIPMENT, FOLLOW SAFE PROCEDURES DURING HANDLING, BE SURE SAFETY EQUIPMENT IS USED, AND KEEP A SUPPLY OF FRESH WATER WITHIN ARM'S REACH. DO NOT BECOME CARELESS AT ANY TIME.

3.03

Q. How deep should anhydrous ammonia be placed to avoid nitrogen losses?

A. The proper depth depends on soil moisture content, soil texture, application rate and the soil physical condition. If these factors, especially soil moisture content, are optimum the depth can be as little as 7-10 cm. The farther these conditions are from optimum, the deeper the ammonia must be placed. Fifteen to twenty centimetres may be necessary for some conditions such as dry, coarse textured soils.

Imagine the zone of ammonia placement as a continuous cylinder running through the soil. The diameter of the cylinder is determined by how far the ammonia moves before it is absorbed into soil water. A soil at field capacity, (all the water it can hold), will absorb ammonia very quickly and the cylinder will have a small diameter. As conditions become drier, the cylinder diameter expands and ammonia must be placed deeper in the soil. Coarser soil texture and higher application rates also cause a larger cylinder and necessitate deeper placement.

3.04

Q. How will I know if I'm getting the anhydrous ammonia deep enough?

A. If there is no noticeable ammonia odor and if wisps of white ammonia gas cannot be seen right behind the applicator, the operation is a success. It is easy to tell when ammonia is being lost because of the obnoxious odor. The reaction within the soil is almost immediate. If anhydrous ammonia is not lost within a few minutes of application it will not be lost at all.

3.05

Q. Does anhydrous ammonia make the ground hard?

A. There are no data to indicate that anhydrous ammonia adversely affects soil physical properties such as density and structure. The claim of ammonia hardening the ground is best categorized as **unsubstantiated rumor.**

It is possible that several circumstances could give rise to such a rumor. Continuous cultivation and long-term cropping of Alberta soils have resulted in a decline in soil organic matter levels. Organic matter is an important component in keeping soils mellow and promoting good structure. Cultivation has also been disruptive to soil structure and caused compaction such as plow soles or hard pans. At the same time, crop removal and higher yield potentials have increased nitrogen fertilizer requirements. Anhydrous ammonia accounts for a substantial portion of nitrogen sales in Alberta. Since decreasing soil workability has occurred at the same time as increasing anhydrous ammonia use, one could be misled in assuming that there is a cause and effect relationship.

In western Canada and U.S., organic matter levels have decreased as a direct result of the practice of summerfallowing. We have also seen an increase in the use of fertilizer. In fact, nitrogen fertilizer will become more and more necessary as organic matter levels decrease. Reduced organic matter is not caused by the fertilizer: it is caused by tillage, which speeds up the decomposition of organic matter. In fact, nitrogen fertilizer in association with recropping has led to increased levels of soil organic matter.

3.06

Q. Does anhydrous ammonia kill soil organisms such as bacteria and earthworms?

A. High concentrations of ammonia are toxic to organisms including bacteria, worms and seedling plants. When anhydrous ammonia is applied in the soil, bacteria and other organisms are reduced in the zone of placement. However, the populations recover rapidly, usually within a few days, and will usually reach higher numbers than prior to application. This is due to the extra nitrogen and soluble carbon that has been added to the system.

An unanswered question is that of how anhydrous ammonia affects the relative numbers of different types of organisms. Even though total numbers may not be affected over the long run, ammonia could shift the balance away from some beneficial species. Of course it could help benenficial species just as easily - there just isn't any information available on this aspect.

3.07

Q. Since ammonia is toxic to seedling plants, how long must I wait between application and seeding?

A. A minimum waiting period of 2 days is generally recomended. However, it should be recognized that the time required for anhydrous ammonia to dissipate to safe levels can vary widely depending on the rate of application, depth of application in relation to seeding depth, soil moisture and soil texture.

If there is doubt about seeding too soon, some precautions may help minimize damage. Apply the ammonia crosswise to the direction you will seed. This avoids having the drill openers follow an ammonia application track, damaging a row at a time. Deeper ammonia application will also avoid seeding directly into the middle of the zone of placement.

3.08

Q. When is the best time to apply anhydrous ammonia?

A. The most economical way to use anhydrous ammonia may be to install the regulator and distribution tubes on your normal chisel plow and combine nitrogen application with a regular tillage operation. Late fall application is excellent, as is early spring application. Research indicates that spring, pre-plant applications are best for sugar beets. Applying phosphorus fertilizer in the same operation may improve efficiency and reduce the amount of fertilizer handling at seeding time.

SECTION 4. PHOSPHORUS

4.01

Q. Why is banding of phosphorus fertilizer so important?

A. Phosphorus efficiency is much higher when the phosphate is banded or seed placed than when broadcast in soils testing low in phosphorus. As soil test levels increase, the difference in efficiency decreases. Efficiency of broadcast phosphorus can be especially low in calcareous or strongly acid soils. Banding reduces the contact between the soil and the fertilizer particles, thereby slowing up the formation of insoluble phosphate compounds which reduces availability to plants. Plants normally take up most (90%) of their phosphate requirement in the first 40 days of growth. Therefore, placing the phosphorus in a band near the seed has proven to be very beneficial to plant growth and yield.

4.02

Q. If I broadcast and incorporate phosphorus, how much more will be required than if I band it?

A. *The Alberta Fertilizer Guide* Agdex 541-1, tells you that 2 - 4 times as much phosphate must be broadcast (broadcast and incorporated) to be equivalent to a band application. The actual difference depends upon the soil test level. At very low soil test levels the broadcast application should be about three or four times as much as the banded rate. At high soil test levels the broadcast and band amounts may be about equal.

4.03

Q. If I have to broadcast phosphorus, what happens to the extra fertilizer, that is, the amount in excess of the banded rate?

A. The extra phosphorus stays in the soil and becomes part of the reserve pool, although it will be changed to less available forms. This extra phosphorus will be reflected in higher soil tests over the long run and lower annual applications will be necessary.

Large applications of phosphate intended to last several years have been shown to work, but the economics of these applications must be carefully considered. This approach is often called "banking" phosphorus.

4.04

Q. I can't incorporate phosphorus on no-till grain or on existing perennial forages. What should I do?

A. The best approach is to ensure an optimum soil phosphorus supply, (as reflected by the soil test) as early as possible in the life of the forage crop. On low testing soils an initial large application of phosphorus will be required, followed by smaller annual or semi-annual maintenance applications.

Large application of phosphorus should be incorporated prior to forage establishment. Surface application of phosphorus on established forage may take a year or more to show a yield response.

4.05

Q. How much phosphorus can I place directly with the seed?

A. All the phosphorus applied to annual crops has traditionally been drilled in near the seed at seeding time. High rates of fertilizer phosphorus can be damaging to crops such as canola and flax when drilled with the seed. Therefore rates of application should be restricted to 20 lb/ac for seed placement with these crops. Disker and hoe type drills cut a wider furrow than single or double disc drills and seed and fertilizer is scattered across the bottom of the furrow. This results in lower concentration of fertilizer close to the seed and therefore is less likely to damage sensitive crops when high rates of fertilizer are applied. Equipment for band placement is becoming more common and is recommended for applying high rates of phosphorus on fields to be seeded to sensitive crops such as canola.

SECTION 5. POTASSIUM

5.01

Q. Should I be using potassium (K) in my fertilizer program?

A. As is the case with other fertilizer nutrients, use of potassium (K) should be determined on the basis of crop response in terms of yield and or quality. (Does the increase and/or quality more than pay for the cost of the fertilizer?)

Soil tests and field trials should be used to establish whether or not potassium fertilizer is required. Potassium deficient soils occur most frequently in parts of west central, northwestern (excluding Peace River region) and northeastern Alberta.

Note: See answer to 5.02 for further discussion.

5.02

Q. Does the potassium soil test accurately predict when potassium fertilizer should be used?

A. Yes! A soil test can identify potassium deficient soils, but on soils with marginal levels of potassium, test strips should be used to establish whether or not the addition of potassium is beneficial. Test strips with and without potassium should be carried out with adequate application of nitrogen, phosphorus and other nutrients required. The identification of potassium deficient soils by soil test and the use of test strips to verify the need for potassium in a marginal situation is a fairly straight forward matter.

A more recent and controversial question is "should potassium be included in the fertilizer program on soils which have adequate levels of potassium by soil test?" This question is posed frequently because some soil testing labs and fertilizer dealers are recommending the use of potassium on soils which have adequate levels of potassium by soil test. These recommendations are based primarily on work done in Montana, Washington, and Oregon. The Montana work suggests that some soils that test high in available potassium sometimes do not supply adequate potassium to crops. This has not been documented elsewhere.

The use of potassium chloride on wheat in Washington and Oregon is associated with disease control. Chloride has been shown to help control the root rot disease "Takeall". Work is underway in Alberta to determine if potassium chloride is helpful in controlling common root rot of barley and wheat.

Over the years there have been numerous trials with potassium on both potassium deficient and non-deficient soils. The frequency of response to potassium fertilizer on non-deficient soils has been very low. Therefore the inclusion of potassium in the fertilizer program on soils that do not test low in potassium is likely a waste of money unless response to potassium has been established in field trials. Research on the effect of potassium chloride on root diseases should help to clarify if and when potassium chloride is beneficial on non-potassium deficient soils.

5.03

Q. What rates of fertilizer potassium are necessary to provide adequate nutrition?

A. Most potassium deficient soils in Alberta test in the moderately deficient range (150 to 250 lb/acre). These soils seldom require potassium applications above 15 to 30 lb/acre banded or placed with the seed for cereal crops. On soils testing very low in potassium (less than 100 lb/acre), higher application rates are required to completely overcome potassium deficiency. On some very potassium deficient soils, initial applications of 300 lb/acre or more plus annual band applications of 30 to 60 lb/acre have been required to overcome potassium deficiency in barley.

5.04

Q. When and how should potassium be applied for maximum effectiveness?

A. For cereal crops, application rates of to 30 kg/ha should be banded or broadcast-incorporated to avoid seedling injury. At low rates, broadcast applications tend to be less effective than seed placed or banded potassium. The higher application rates required when broadcasting (1.5 to 2 times seed placed or banded) will help to build up soil potassium levels.

Potassium fertilizers are not subject to leaching or volatilization. Therefore they can be applied in fall or spring. Potassium moves slowly in soil. Therefore incorporation will help to move it into the root zone.

5.05

Q. Should I be using potassium on forage crops?

A. Forage crops have a higher potassium requirement than cereal crops. Also potassium removal in cereal grains (straw not removed) is only about 20 lb/ac (K_2O) as compared to 100-200 lb/ac for perennial forage crops. On the other hand, perennial forages appear to be more efficient in taking up potassium from marginally deficient soils probably because they have a more extensive and deeper root system. As a result, perennial forages tend to be a little less prone to potassium deficiency than cereal crops on marginally deficient soils. However, when potassium deficiencies occur on forage crops, higher rates of application are required than for cereals.

SECTION 6. SULFUR AND MICRONUTRIENTS

6.01

Q. Is sulfur deficiency a widespread problem in Alberta?

A. Sulfur deficiency is quite common in northern and western central Alberta, but it is found in other localized areas as well. Sulfur deficiency is most frequent on gray wooded soils and on coarse textured soils, but there are many exceptions. The deficiency is rare in southern Alberta, however, even there deficiency has been found. Some soils are deficient in the topsoil but have enough in the subsoil to meet crop requirements. Sour gas plants may add minor amounts of crop-available sulfur, but in the balance throughout Alberta yields are increasing with time from improved farming and soils are becoming more depleted in sulfur. It is estimated that about five million acres of cultivated land in Alberta are deficient, or nearly so, in crop available sulfur. Approximately 5 lb/ac of sulfur is added to the soil annually in rainfall. On irrigated land about 10 lb/ac of sulfur is added to the soil with each 10 cm application of irrigation water.

6.02

Q. How can I identify a sulfur deficiency?

A. The soil test for sulfur is fairly reliable. The soil test points out soils which have enough crop-available sulfur so that sulfur fertilizer is never needed. It also points out soils which are so low in crop-available sulfur that crops will always respond to sulfur fertilizer. Often there are borderline amounts of soil test sulfur and there the possibility of response is difficult to predict.

One can detect severe sulfur deficiencies by visual examination of crops. Such crops are stunted and are yellowish in color. Canola tends not to set seeds. When the deficiency is only slight, the crops do not have easily distinguished symptoms. Placing a narrow marked strip test (for example, a drill width) with sulfur fertilizer the length of a field, gives a fairly precise visual test. Even if the yield response is modest, crop leaves would be slightly darker in color in the test strip, and for canola the amount of seed set would be greater in the test strip.

6.03

Q. How much sulfur is required to correct a deficiency?

A. When the deficiency is severe, only 10 lb/acre is needed for cereal grains, and 15 to 20 lb/acre for canola or legume hays. Of course, if the deficiency is less severe the amount of fertilizer sulfur can be less. It is important to realize that for cereal grains, canola, and grasses, sulfur deficiencies appear only when nitrogen fertilizer is added. That is to say, soils deficient in sulfur are usually deficient in nitrogen, and so on these soils both sulfur and nitrogen fertilizer are needed. For cereal grains and grasses only 1 part of fertilizer sulfur is required for 10 parts of fertilizer nitrogen. For canola the ratio of sulfur: nitrogen may be 1 part to 5 parts. Applying more sulfur than indicated by those ratios will do no harm to the crop, but will be of no measurable help. Adding a heavy rate for one crop, so that sufficient sulfur will carry over for the second crop is not a practice to count on, because the sulfur may be tied up in unavailable organic form in the soil after a year.

6.04

Q. Are all sulfur fertilizer sources equally available to crops?

A. Conventionally, sulfur fertilizers have been based on sulfate (SO_4) which is immediately available to crops. Examples of these fertilizers are 34-0-0(11), 21-0-0(24), 16-20-0(14) and 40-0-0(5). Recently a number of fertilizers based on elemental sulfur have been made available. Some of them are converted to plant available forms very slowly and may take several years to benefit crops. Dry urea pellets impregnated with finely divided elemental sulfur, or liquid fertilizers with an emulsion of finely divided elemental sulfur will become partly available in the growing season of the year of application. A liquid fertilizer with ATS (ammonium thiosulfate) is all available within the growing season.

6.05

Q. Are micronutrient deficiencies of concern in Alberta?

A. Micronutrient problems are not common and are restricted to specific micronutrient-crop-locality combinations. You certainly shouldn't consider micronutrients unless the requirement for the major nutrients is satisfied, and then only when a specific deficiency is identified by soil, or plant tissue testing or field tests.

Zinc deficiency of beans has been identified on some fields in the irrigated areas of southern Alberta. Zinc deficiency occurs primarily where soils contain large amounts of free calcium carbonate (lime) near the surface. This is often due to exposure of the subsoil by plowing or leveling. Extremely high levels of phosphorus may also induce zinc deficiency. Responses of small grains to zinc have not been found. Deficiencies of zinc have been investigated in corn and sugar beets but consistent responses have not occurred.

Alfalfa is sensitive to boron deficiency on soils with low boron content. Boron deficiency of alfalfa is characterized by white color of the top (bud area) and subsequent death of the plant. Iron deficiencies are occasionally found on crops growing in waterlogged soils and on ornamental plants growing in calcareous soils.

Copper deficiencies have also been identified in cereal crops grown on calcareous organic soil in central Alberta.

We will probably continue to identify infrequent micronutrient deficiencies. However, they are not very widespread and only affect crops under certain sets of circumstances.

- Also see *Micronutrient Requirements of Crops in Alberta* Agdex 531-1.

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